Credit risk and economic downturns: Stress-testing

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Background: bank capital

![Graph showing expected loss and worst-case loss over time horizon with a buffer for capital.]
Background: Basel IRB approach

\[ K = (CPD \times LGD - PD \times LGD) \times M \times EAD \]

\[ CPD = \Phi \left( \frac{\Phi^{-1}(PD) + \sqrt{\rho} \Phi^{-1}(0.999)}{\sqrt{1 - \rho}} \right) \]
What is ‘Stress-Testing’?

- Basel Committee: additional calculation for economic and/or regulatory capital: [...] identifying possible events or future changes in economic conditions that could have unfavorable effects on a firm’s credit exposures and assessment of the firm’s ability to withstand such changes. Examples of scenarios that could be used are:
  - Economic or industry downturns,
  - Market-place events, or
  - Decreased liquidity conditions.
Berkowitz critique on stress-testing

- Berkowitz (2000):
  - Risk model should contain all possible scenarios;
  - VaR describes an unlikely scenario (e.g., worst of 1,000 scenarios);
  - Include all possible scenarios in risk model if this is not the case;
  - If risk model includes all possible scenarios, then stress-testing is impossible.

⇒ value of stress-testing may be limited
Stress-testing – practical view

- Stress-testing is an addition to the (imperfect) risk model;
- Practical problem: probabilities of stress-scenarios are unknown.
Stress-testing – practical view (cont.)

Credit risk

Stress of unobservable random factors

Market risk

Stress of observable factors

Operational risk

Stress of model parameters

Stress of model assumptions
PD model

- Factor model for the latent asset return

\[ R_{it} = \gamma_0 + \gamma z_t^D + \omega F_t \]

- Conditional PD

\[ CPD_t(F_t) = \Phi \left( \frac{\gamma_0 + \gamma z_t^D - \omega F_t}{\sqrt{1 - \omega^2}} \right) \]
LGD model

- Factor model for the LGD or recovery

\[ RR_t(X_t) = \Phi(\beta_0 + \beta z_t^R + bX_t) \]

- \( F_t \) and \( X_t \) are correlated (e.g., two-dimensional normally distributed)
US mortgage loan portfolios

![Graph showing delinquency rate and charge-off rate over time.](attachment:graph.png)
Hong-Kong mortgage loan portfolios
Empirical results

- PD und GDP move in opposite directions ($\hat{\gamma}_1 = -2.842$);
- RR und GDP move in same directions ($\hat{\beta}_1 = 19.232$);
- Asset correlation ($\hat{w}^2$) is 6.8%;
- Correlation between asset return process ($F_t$) and recovery process ($X_t$) is positiv ($\hat{\rho} = 0.195$).
Stress approaches

- Stress Approach 1: Stress of the systematic random variables $F_t$ and $X_t$;
- Stress Approach 2: Stress of the systematic random variables $F_t$ and $X_t$ and GDP;
- Stress Approach 3: Stress of the systematic random variables $F_t$ and $X_t$ and the model parameters;
- Stress Approach 4: Stress of the systematic random variables $F_t$ and $X_t$ and GDP and the model parameters.

Here: Separate probabilistic stress of PD and LGD parameter (percentiles). Extensions possible.
Comparison of stress methodologies. The values are based on a Monte Carlo simulation with one million iterations.

<table>
<thead>
<tr>
<th>Stress Approach</th>
<th>Mean</th>
<th>Median</th>
<th>0.95 percentile</th>
<th>0.99 percentile</th>
<th>0.999 percentile</th>
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<td>Stress Approach 1</td>
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<tr>
<td>PD</td>
<td>0.033</td>
<td>0.033</td>
<td>0.083</td>
<td>0.115</td>
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<td>PD</td>
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<td>0.088</td>
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<td>LGD</td>
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<td>0.052</td>
<td>0.100</td>
<td>0.180</td>
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</tbody>
</table>
Recent Papers by Daniel Rösch and Harald Scheule

- Forecasting probabilities of default and loss rates given default in the presence of selection, forthcoming Journal of the Operational Research Society
- Capital incentives and adequacy for securitizations, 2012, Journal of Banking and Finance, 36, 733-748
- Default and recovery risk dependencies in a simple credit risk model, 2011, European Financial Management, 17(1), 120-144
- Downturn credit portfolio risk, regulatory capital and prudential incentives, 2010, International Review of Finance, 10(2), 185-207
- Stress-testing credit risk parameters: An application to retail loan portfolios, 2007, Journal of Risk Model Validation, 1(1), 55-76
Recent Books by Daniel Rösch and Harald Scheule

- **Stress-testing for Financial Institutions** - Applications, Regulation, Techniques, 2008 RiskBooks
- **Model Risk** - Identification, Measurement and Management, 2010 RiskBooks
- **Credit Securitisations and Derivatives**, 2012 Wiley